

THE SURGICAL TREATMENT OF SPINA BIFIDA.¹

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THE surgery of to-day demands the revision of the dicta of yesterday upon many of the operative questions considered settled. Few have seemed more clearly determined than the negative to the interrogatory, Are the varying conditions usually classed under the general name of spina bifida amenable to surgical treatment? The experience of the generations appeared sufficient to determine against further experimental operative interference. However, an analysis of the cases reported points to the many fatal failures as incident to the one general cause, the septic infection of the wound. Sepsis *in loco* does not permit the primary closure of the wound, and non-closure means an undue loss of the cerebro-spinal fluid with the consequences which must follow in the changes supervening in the great nerve-centres. The septic infection usually extends rapidly along the spinal canal, and the result is disastrous.

What wonder all attempts at cure in the earlier period were almost necessarily followed by death! Are we in a condition, by methods at present at our command, to reverse the verdict as transmitted to us from the past, and which is still generally accepted? *A priori* reasoning would lead to the conclusion that art could supplement nature in her defective development. The simplest consideration of the subject in its varying phases presents a hernial tumor containing cerebro-spinal fluid; the opening through which the tumor escapes being caused by a defect in the bony support of the spinal canal and its envelopes.

The varying of the conditions, as well as location in the

¹ Read before the Southern Surgical and Gynæcological Association, November, 1894.

spinal column, causes great diversity in the size and shape of the protruding tumor.

The hydrostatic pressure is greatly increased the lower the opening in the canal, and, as a consequence, the greater the dilating force exercised upon the hernial envelopes when the patient is in an erect position.

Granting that the operation can be successfully performed, the liability of the return of the hernia diminishes the higher the vertebral opening. If the opening is in the lower part of the canal, can the soft parts be utilized so as effectually to prevent a return of the hernia? The limit and purpose of this paper hardly permit the discussion of some very interesting phases of the subject. Do we find the envelopes of the sac unimportant, allowing their removal without serious injury to the organism? Is it usual that important nerve filaments are distributed over the interior of the sac, and that their removal may inflict a permanent injury? Is paralysis of important nerve functions to follow?

Cerebral surgery has taught that, under proper care, the envelopes of the brain may be opened with comparatively little danger; even the great cerebral centres are invaded with a minimum of risk. Laminectomy may be undertaken with very little danger to life, and tumors of the spinal cord are considered within the domain of the surgeon. The reasons of advance in these directions are all found in the surgical skill applied under aseptic conditions. The skill itself, from either the anatomical or surgical stand-point, is very little, if any, more perfect than that which was exercised a generation ago. From the above, the inference is that the aseptic operation upon a spina bifida should not be especially dangerous.

Undertaken with a reasonable minimum of danger to life, is it possible to reform and reinforce the structures so as to effect a permanent cure?

I have felt for a long time that the essential features of the surgical treatment of spina bifida were the same as in the operation for the cure of hernia. The isolation and the removal of the sac (having first ascertained its contents) and the reinforcement of the structures in a way to prevent as far as possible the return

of the tumor. Although there may be a considerable variation in the pathological conditions found in operable cases of spina bifida, the one important consideration to be kept in mind is that the sac of the tumor is in direct continuity with the spinal canal, and that the fluid contained therein is in intimate relation with that surrounding the great cerebral centres. Undue loss of this fluid in the opening of the sac may result in sudden death, because of changes incident to the disturbed relations of the intracranial organs. On this account the head must be considerably lowered prior to the opening of the sac.

A free dissection is necessary, elliptical incisions being made upon either side, reserving ample lateral flaps to compensate for the retraction of the distended covering. It is wise to carry the dissection entirely to the base of the tumor before opening the sac, since, owing to the distention, the relation of the structures is more easily defined. Having placed the patient upon an inclined plane, the sac should now be emptied, and this is best effected by a trocar in order that the fluid may be somewhat slowly withdrawn, and thus the operator can observe the changes, if any occur, in the cerebral centres.

It is also a matter of interest to note the amount of fluid contained in the sac.

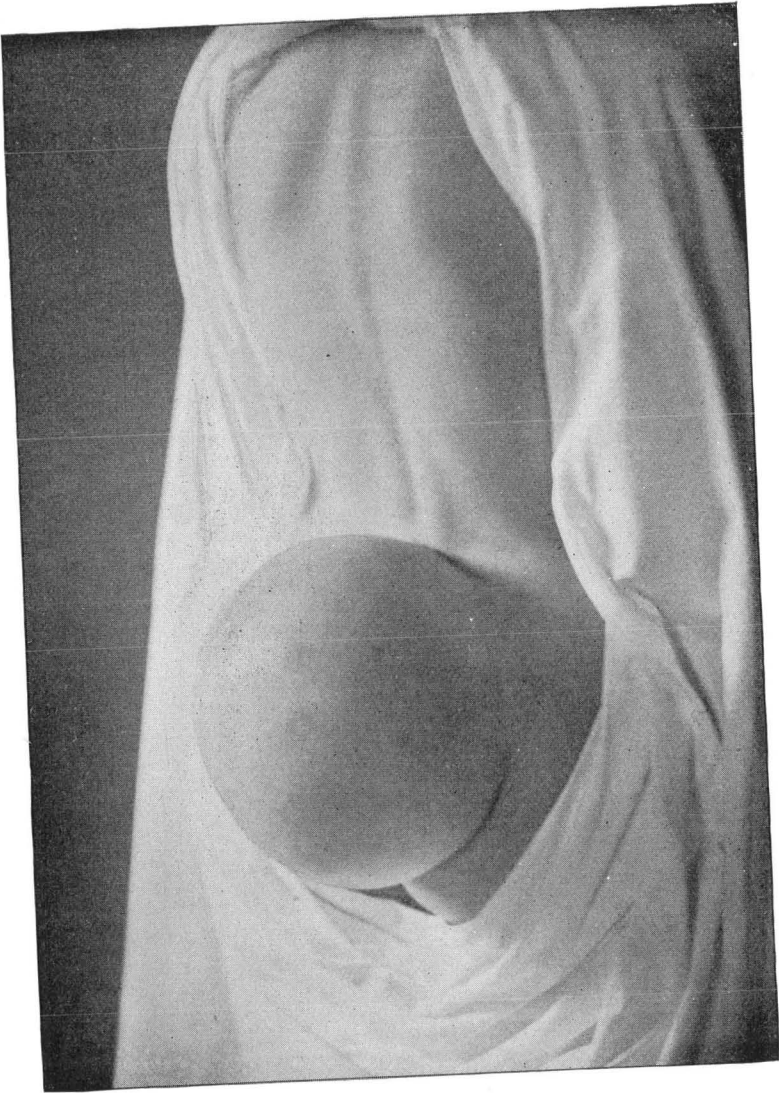
Owing to the fact that certain more or less important portions of the spinal cord are often spread out upon the inner wall of the sac, it is best to open the sac freely and dissect the same, if possible, for the purpose of returning any nerve filaments thus found within the spinal canal. This having been effected, the walls of the sac are carefully held by an assistant, in order that the base may be coapted by suturing. This is best accomplished by the use of a needle with eye near the point, so as to apply a double continuous suture which encloses the entire base of the tumor in even uniform compression, the stitches being subdivided as the operator judges advisable. It is well to remember that coaptation and compression sufficient to prevent the leakage of the fluid is all that is desired; force beyond this, applied to the parts enclosed, cuts off the circulation in the tissues and may lead to necrosis of even aseptic structures. A tendon suture is

greatly preferable to catgut, since it is much more slowly absorbed. An aseptic animal suture is important, since it is deeply buried and must remain in close approximation to very important structures.

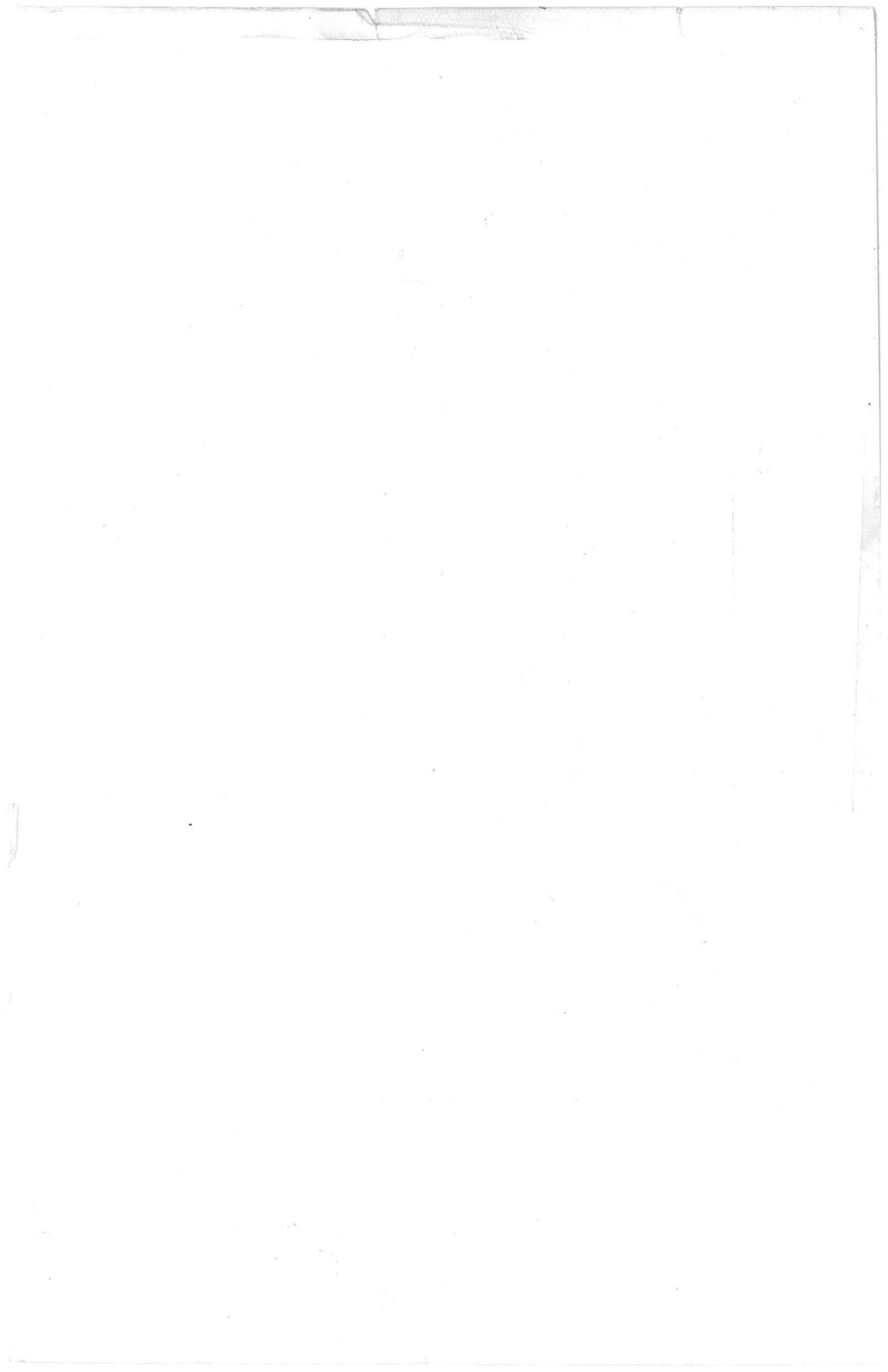
The sac is now cut away at about an half inch exterior to the line of suturing in order to allow sufficient tissue for intra-folding the divided edges, which is done by a parallel suture introduced from side to side. The stump thus sewed across, the next important step in the operation is to anchor it firmly for the permanent support of the reformed spinal canal and reconstruct over it as strong supporting structures as possible. To effect this, the stump is closed down upon either side to the strong fascia of the quadrati muscles. Efforts have been made for the planting of periosteum for the purpose of reforming the spinal arches of the vertebra, but with doubtful success. Generally the osseous structures are so wanting that it is very difficult to find the lateral arches and utilize them for any purpose. The more or less considerable superficial wound is now closed with buried animal sutures, the skin itself coapted in this way, and the wound sealed with iodoform collodion, reinforced with a few fibres of absorbent cotton. A wound so treated, if aseptic, must thus remain, and if non-infected primary union will supervene.

I am now fortunate in being able to report a typical illustrative case, to which I subjoin a brief history of the operation :

Miss B., aged eighteen; healthy family; normal development at birth, except a soft swelling under the skin in the lumbar region, the size of half an orange. This has steadily grown until the present, rather more rapidly of late. The patient has been in fairly good health, a little below the average in height, weight 115 pounds. Is intellectually very bright, vivacious, and fond of her books and music. For some years she has worn an elastic supporter, adjusted to the shape of the tumor and encircling the body. Tumor not sensitive to touch or compressible. Circumference in its largest part, twenty-nine inches; measurement in line of spine is nineteen inches; transverse, eighteen inches; nearly circular in shape. Wave impulse distinct, with the covering evidently very much thinned out upon the right side. She has slightly club-feet with indrawn toes, otherwise is



DR. MARCY'S CASE OF SPINA BIFIDA.



normally developed. Has consulted many surgeons, who have invariably advised against surgical interference.

I determined upon operation because of the increasing size and extreme thinness of the sac, believing rupture imminent. The patient gladly sought relief, as she was becoming morbidly sensitive on account of her deformity, and exercise was limited with an ever-increasing caution and fear.

Operation performed October 16, assisted by Dr. H. C. White, G. L. Amerman, and H. O. Marcy, Jr. Elliptical incisions were made through the skin upon the cyst-wall, and the flaps were dissected quite to the base upon either side, the pedicle being about three inches in diameter. Elevated the hips of the patient so that the spine was upon an angle of perhaps fifteen degrees before opening the sac. The tumor contained one gallon of perfectly clear, colorless fluid, which was drawn off by means of a trocar. Specific gravity of fluid 1.010. Slight trace of albumen. A little to the right of the median line the cauda equina was spread out upon the wall of the sac, perhaps two inches in width. This I carefully dissected and returned within the canal. The walls of the sac at its base were very much thicker than elsewhere. The opening was nearly three inches in length, through the two lower lumbar vertebræ. The base was closed carefully with a double continuous kangaroo tendon suture, and the sac was cut away. The cut edges were intrafolded by a continuous parallel suture taken from side to side. The base was then stitched carefully to the strong aponeurotic fascia of the quadrati muscles laterally. Then the wound, the size of a large dining-plate, was closed down with lines of running buried tendon sutures in order to leave no pockets or open spaces, and the skin brought into apposition with a buried suture, as in laparotomy, and sealed with iodoform collodion. A small drainage-tube was inserted in the lower angle of the wound, which was removed the second day. The union was entirely primary and the recovery rapid. For a day or two she complained of burning sensations in and twitchings of the feet. No cerebral disturbances. There was slight paralysis of the sphincters, which disappeared at the third week.

At the time of writing, November 9, patient is up and dressed. The cicatrix is firm and not tender. Only a slight line marks the place of incision. She has been kept for the most part in the horizontal position, that the hydrostatic pressure of the fluid

in the spinal canal may not dilate the consolidating structures.¹ I find no case reported where the tumor had developed to such an extraordinary size.

The subjoined operative cases have been found after a careful search of the medical literature extending through a very considerable period. It is very likely incomplete, but it shows that the operation was first intelligently advised and successfully executed by American surgeons. If ever operative measures become the rule in practice, they must be based upon aseptic principles; the resected parts closed and reinforced by buried animal sutures, preferably tendon, to be followed by primary union. Under these conditions I confidently await the verdict of the future.

I quote the first suggestions which I find as to the operative treatment of spina bifida from the work of Sir Charles Bell, published in 1791.²

“But if the opening between the spinous processes of the vertebræ with which it is always accompanied be not the *effect* of the disease, as it is commonly supposed to be, and if the want of support which this deficiency of bone must create to the membranes of the spinal marrow be the *cause* of serous effusions within these membranes, might not some advantage be derived from applying a ligature round the base of the tumor, not merely with a view to remove it, but also to draw the bottom of the cyst so closely together that it may act as a proper support to the parts beneath? Whether any benefit may be derived from it or not is no doubt very uncertain; but in a disease which we know will otherwise terminate fatally, we are warranted in proposing whatever can afford even the smallest chance of safety; so that I mean to attempt it in the first case of this kind that falls under my care.”

Sir Astley Cooper reported two successful cases of spina bifida cured by repeated tapings followed by compression.

Dr. A. Trowbridge,³ of Watertown, N. Y., so far as I have

¹ Patient was discharged from hospital at the end of the sixth week, wearing an elastic compression-pad when in the upright position. Improvement in every way rapid. Cicatrix firm and unyielding. She is resuming her studies, and with care is permitted to take short walks, rides, etc.—February 1, 1895.

² A System of Surgery, by Benjamin Bell, Vol. iv, p. 74.

³ Boston Medical and Surgical Journal, Vol. 1, No. 48, January 23, 1829.

been able to find, was the first who attempted to put in practice the suggestion of the great Edinburgh surgeon.

His first case was a boy of eighteen months, otherwise healthy. "Tumor over lower cervical vertebræ, size of an egg, entirely covered with cellular substance. Small silver wire was put around base of swelling, passed through a canula, and brought moderately tight, so as to produce slight inflammation on the surface at its base. At the end of second day I passed scalpel on outer side, close to wire, divided and separated outer portion. A preternatural opening was perceptible between two lower cervical vertebræ into spinal canal. Discharge of fluid from small opening in centre. Wound completely healed and child cured."

His second case was a boy two and a half years old. Tumor over three lower cervical vertebræ, seven inches in circumference. Wire and canula placed on base. Ligature remained four days, then drawn tightly to prevent circulation. Nine days from first application cut away the tumor above ligature. Ligature came off, followed by the spouting of a wineglassful of turbid lymph, tinged with blood, from small opening in spinal canal. In four weeks the whole wound was cicatrized and sound.

His third case was a child four years of age. "Large tumor over sacrum and three lower lumbar vertebræ. At time of operation tumor was thirteen inches in circumference, seven inches at base. Incision through integuments, leaving enough to cover wound. A cavity was presented containing several cysts or sacs, resembling intestines, filled with fluid. Removed whole by dividing membranous attachments near the spinal muscles. Child recovered and remains well."

Dr. Brainard, of Chicago, appears to have been the first to practise the injection method with solutions of iodine, having published his results in 1848.

Morton revived the practice, and in Europe this procedure is called the Morton method. Tavignat, in 1844, reported a case of excision of the sac and suture of the wound. Death supervened from inflammation.

Dr. William Judkins¹ reported a case of spina bifida cured

¹ Western Medical Journal and Physical Sciences, Cincinnati, 1837.

by ligature. Tumor size of an egg in lower cervical vertebra. Child three months old. He ligated at first loosely, then tighter, and at last very tightly. Slough separated the tenth day. Cure remained two years later.

Dr. A. G. Purdy¹ reported a case of spina bifida upon which he operated in February, 1842.

The child was about a week old; tumor in lumbar region, size of a small orange with a neck about one inch in diameter. The surface was ulcerating. The sac was opened and the spinal cord was clearly seen. The integuments were carefully dissected to the neck and the sac excised. There was a slight oozing for some weeks. Paralysis of one leg followed, which did not entirely disappear until the third year. The cure was considered perfect.

Mr. W. B. Page² reported a case of a child twenty-one months old. Tumor in lower lumbar vertebræ. Spheroidal in shape, measuring seven inches in circumference and five at its base. Covered with skin. After repeated attempts at removal by constriction with the elastic ligature, the tumor was dissected to its base and the cyst ligated very tightly. The skin sloughed. The ligature came away on the sixth day, the cicatrix slowly contracted and remained firm. The cure was reported as complete.

Dr. L. A. Sayre,³ of New York, reported a case of spina bifida in a child two years of age. She had a fluctuating, pendulous tumor about the size of a hen's egg, with a small neck. It was situated over the sixth cervical vertebra. The sac was transfixed with a double ligature and ligated tightly. On the twenty-third day the ligatures came away, leaving the wound entirely healed. "Query, Was not my success owing entirely to the strangulation by the ligature, thereby cutting off all communication with the spinal canal, and in causing it to heal over, close to its origin, and thereby supplying the place of the bony arches?"

Dubourg⁴ reported a case of cure of spina bifida by the excision of the tumor and the compression of the base of the sac by hare-lip pin sutures.

Dr. J. C. Nott⁵ reported a case of spina bifida cured by excision.

¹ The Annalist, New York, 1846.

² Monthly for Medical Science, Edinburgh, 1847.

³ New York Journal of Medicine, 1849.

⁴ Gazette d'hôpital, Paris, 1849.

⁵ American Journal of the Medical Sciences, 1855.

Child one month old. Tumor in middle lumbar vertebra, size of an egg. "After the sac was removed, an opening into the spinal canal was exposed about the size of the end of the finger, and a tablespoonful of fluid escaped. Closed by pin and twisted suture. Wound sloughed and closed by granulations. Two months later the cure seemed complete."

Royer¹ reported a case of spina bifida located in the lower sacral region, where he excised the sac and sutured, followed by cure.

Dr. Elisha Huntington,² of Lowell, reported a case of spina bifida in a child six months old; otherwise healthy, except a slight varus of one foot. "The tumor hung like a pendulous polypus from over the vertebral column, and about on a line with the crest of the ilia. It had a peduncle, which was about a foot in length and about as large as the little finger, but enlarging somewhat just before it joined the body of the tumor. This last was nearly the size of the two fists." Immediately after the birth, as nearly as possible to its origin, a ligature was applied to the peduncle and the tumor was cut away. The ligature slipped and a nearly fatal hæmorrhage occurred. Recovery was rapid, and the child is strong with only an irregularity of surface to the feel.

Dr. J. B. S. Jackson examined and reported it as a very rare case of spina bifida. The cavity of the peduncle admitted a probe with difficulty. Specimen in Warren Museum, No. 852.

Dr. Henry G. Clarke,³ of Boston, reported a case of spina bifida in sacral region. Girl, seven years old; otherwise in perfect health. Operated on at Massachusetts General Hospital. About one pint of colorless fluid was evacuated by a trocar; specific gravity 1006. Needles armed with strong ligatures were thrust through the base and tied very tightly. Patient suffered very much. The tissues sloughed, and the fluid began to leak on the fourth day. Death occurred on the fifth day. The autopsy, made by Dr. J. B. S. Jackson, showed that the spinal cord was lost upon the inside of the sac, about two inches from the opening, and that at least a portion of it had been included in the ligatures.

Dr. Thomas Smith⁴ reports for Dr. Wilson, under date January, 1868, a case of cure by excision. Child about one month old. Tumor

¹ Bulletin Académie de médecine, Paris, 1855-56.

² Boston Medical and Surgical Journal, July, 1862.

³ Boston Medical and Surgical Journal, 1865.

⁴ Transactions Pathological Society, London, Vol. xiv.

several times aspirated. Five days before operation, he compressed the tumor by a steel clamp. Dissected and excised. "The cut edges of the spinal membranes were lightly touched with a red-hot knitting-needle to promote adhesions. Sutures were applied to the wound and pressure to the pedicle of the tumor. Child recovered from the operation without a bad symptom, and twenty days afterwards, the wound had entirely healed."

Dr. Smith remarks, "Surgically, this case is one of interest, having been the first operation of the kind that has terminated successfully in this country."

Rizzoli, of Bologna, operated in 1869 and again in 1871 upon spina bifida by the use of his specially devised clamp forceps. The compression was graduated so as to cut off slowly the circulation. The cures were complete with firm cicatrices.

Dr. James Weaver¹ presented a child for the inspection of the North Staffordshire Medical Society, upon whom he had operated the preceding June. The tumor was in the lumbar region, attached by ligamentous pedicle or band to space between last dorsal and first lumbar vertebræ. Pedicle two inches or more in length. He had punctured the sac and let out a considerable quantity of fluid on several occasions. He placed a silk ligature about the pedicle, close to the body of the child, tying it, with strict injunctions to loosen it in case convulsions came on. He tightened the ligature daily until July 12, when he removed the dried-up substance. The recovery was rapid and the child remains well.

Case reported by Dr. John Wilson.² Child, two months old. Tumor had been punctured several times. Located in upper dorsal vertebræ. Opened by a free longitudinal incision, dressed with carbolized oil and lac plaster. Recovery slow. At end of two months cicatrization complete. Six months later reported well.

Mr. Atkinson reported a case of spina bifida cured by the use of the elastic ligature. Quite a number of cases are reported as operated on by this method, especially by the Italian surgeons. Obviously elastic compression is, however, applicable to only a small class of cases having comparatively small pedicles.

Dr. W. H. Fitch³ reported a case of cure of spina bifida by

¹ London Lancet, December 10, 1870, p. 841.

² British Medical Journal, 1875.

³ Chicago Medical Journal, 1880.

excision. Child, one year old. Tumor egg-size, situated in lumbar region. Dissected and ligated base. Clear fluid escaped in considerable quantity for nearly two weeks. Patient slowly improved, and three months later reported well.

Mr. W. Pye¹ reported the following case: Child, eight weeks old. Tumor in lumbar region, size of an infant's head. Pedicle about the thickness of a man's thumb. Tumor covered with skin. Chloroformed; clamped the pedicle and removed the tumor. On the fourth day removed clamp. Slough separated the twelfth day.

At the meeting of the Clinical Society of London, on March 27, 1885, Mr. Mayo Robson,² of Leeds, described four cases of spina bifida on which he had operated, exhibiting two of the patients. The first case upon which he operated was described in the *British Medical Journal* for March 24, 1883; it died one year after the operation, from teething convulsions. At the site of the tumor there was only a linear scar. Of the cases presented to the Society one was that of a sixteen-year-old girl who had had the tumor tapped repeatedly, and at the time of operation was apparently sinking from exhaustion. After reflecting the skin by a crucial incision, Mr. Robson excised the sac, and the cavity was drained for a few days. The patient was discharged cured at the end of twenty-four days, with the wound quite healed, and only a scar where the tumor had been.

The second patient shown was a child, aged seven; the skin was dissected from the sac and the redundant sac and integument removed; the meninges were sutured with catgut, and the skin with wire. The patient was discharged cured in thirteen days.

All of these operations were performed under strict antiseptic precautions, a eucalyptus atmosphere being used instead of the usual spray. Mr. Robson called special attention to the principle of closing the meninges by bringing together two serous surfaces, as in peritoneal surgery; to the great importance of employing the strictest antiseptics; to the value of this method in cases in which other forms of treatment are not available, as when the sac is thin or the opening into the spinal canal is large; to the possibility of transplanting periosteum and its capability of surviving; he thought that periosteum from a recently-amputated

¹ British Medical Journal, July 9, 1881.

² New York Medical Journal, April 25, 1885.

limb would give good results. In one case the sac was acutely inflamed, but complete removal with efficient drainage effected a cure.

Dr. R. T. Hayes,¹ of Rochester, N. Y., reported an interesting case where he followed Mr. Robson's method. Child nine and one-half weeks old; otherwise of healthy development. Tumor in lower dorsal region. At birth one-third the size of a hen's egg, but had doubled in size. Chloroformed with head low. Upon aspiration the child immediately collapsed, but rallied slowly. Opened the sac and dissected the superfluous membranes which were closed by six interrupted catgut sutures. Introduced twenty small grafts of periosteum from a freshly-killed rabbit. Union imperfect. Several ounces of serum drawn away during the following days, the sinus discharging until the tenth day; never pus. Three months later the cure is reported satisfactory with a firm, hard, resistant covering. Dr. Hayes comments upon the operation as follows: "I would add to Mr. Robson's points in operating: first, care in removing a portion of the fluid before free incision as a guide to the degree of tolerance in each case, for such a procedure; second, the careful maintenance throughout the operation, and for some time after of such a position of the patient as will most favor the retention by gravitation of the largest amount possible of the cerebro-spinal fluid. Finally, I would remark, the apparent confirmation of the successful application of periosteal grafting in this operation."

Mr. Walter Whitehead² reported to the Royal Medical and Surgical Society an operative case of spina bifida in the Manchester Royal Infirmary. Female, aged twenty-eight. Until twenty-one years of age the tumor gave little discomfort, and was small. Grown more rapidly the last seven years, and patient suffered severely from headache, vertigo, etc. The tumor reached from three inches above the iliac crest to within an inch of the tip of the coccyx; its circumference was twenty-two inches; its transverse diameter fourteen inches. The tumor was tapped, but the cerebral disturbances were more marked. Refilled and gradually drained until sepsis occurred. On November 8, 1883, the treatment having been continued since July, the tumor was laid open, the pus evacuated, and the cavity loosely packed with

¹ Medical Record, June 16, 1883.

² British Medical Journal, January 26, 1884.

iodoform gauze. The wound healed gradually, and two months later the cavity was completely obliterated, no tenderness or discomfort left.

Dr. E. H. Bradford,¹ of Boston, reported the case of an infant of five months. Tumor in the lower cervical region. Operated on by ligation and compression at the base of the sac, with a silver wire introduced subcutaneously. The sac was then excised, and no nerve filaments were found in it. Dressed antiseptically. From the third day there was a slight leakage of serous fluid. Death occurred the fourth day without symptoms of meningitis.

Dr. Thomas Sinclair² reported a case treated by excision. Plump, healthy girl, three months old. Small lumbar spina bifida about size and shape of half an egg, opposite dorsal and upper lumbar vertebræ. A thin translucent pedicle, beautifully injected with an open meshwork of blood-vessels, enclosed about half an ounce of clear fluid. Operated September 21, 1885. Cut rapidly around junction of pedicle and skin, but could not remove it on account of a strong fibrous cord attaching its summit to base. He cut through it. Touched skin edges and peripheral parts of base with nitrate of silver. Wound granulated kindly, and patient discharged at the end of one month.

Mr. J. K. Barton³ reported an interesting case of spina bifida in a child two weeks old. Sac was excised under careful antiseptic precautions, and the flaps drawn together by a double row of sutures. Wound dusted with iodoform, and dressed with iodoform gauze. There was no elevation of temperature, and the union was complete and firm in a week. Discharged in ten days cured without loss of power in limbs. After writing the report, information had been received of the death of the child in a fit of convulsions.

Dr. F. J. Groner⁴ reported a case of spina bifida. Child three months old. Tumor in cervical region; sac three and a half inches in diameter. Dissected, transfixed with a double catgut ligature, tied and cut away sac. Slight subsequent escape of fluid. Union complete the seventh day. Dr. Groner raises the query, Why not operate under modern aseptic precautions with success?

Dr. Z. H. Evans⁵ reported a case of surgical treatment of spina

¹ Boston Medical and Surgical Journal, February, 1886.

² Dublin Journal of Medical Sciences, March 8, 1886.

³ London Lancet, October 2, 1886.

⁴ American Lancet, 1888.

⁵ New York Medical Journal, August 25, 1888.

bifida with illustrations of the case before and after operation. Boy six years old. Two sisters of the mother had given birth to children with spina bifida, her child being the fourth in the family. Tumor size of an orange, attached to the second and third lumbar vertebræ. A small piece of necrosed bone was found in a pus pocket. Upon dissection the sac led down to an opening the size of a lead-pencil to the cleft, which would admit the thumb. The cord was clearly exposed to view. The sac was excised and sutured. The third day there were convulsions, followed by a free discharge of spinal fluid. This continued for three weeks. Cicatrization went on slowly until at the end of three months the back was entirely free from pain and tenderness. Upon looking up the subject, Dr. Evans meets the long array of surgical authorities opposing the operation, and failed to find the record of any cases submitted to successful surgical treatment. He therefore points to his case as the first on record, resulting in a permanent cure.

Bayer¹ reported a successful case operated on where the sac was dissected to its base, opened, and the cauda was replaced in the spinal canal. The sac was sutured, and the wound closed. He suggests the possibility of forming a bony covering by making lateral periosteal flaps from the canal of the sacrum.

Dr. E. P. Hurd, of Newburyport, reported a very interesting case of operative treatment. Child seventeen months old. Tumor size of a large bowl, covered the sacral region as far down as the cleft of the buttocks. Aspirated a pint and a half of fluid as thin and clear as spring water. Operation October 15, 1889, assisted by Dr. G. W. Jones. A linear incision was made over the tumor, freely exposing the whole of the sac. The cauda, which was spread out over the surface, was traced to an indentation over the last lumbar vertebra, through which a probe was passed into the spinal canal. A considerable portion of the surplus integument and the sac were hastily removed, and the edges of the incision brought together, with a continuous catgut suture, and covered with flexible collodion. Five days later the wound opened, and about a pint of fluid escaped. The following day the remainder of the sac was dissected to its base, and wound closed with continuous chromicized animal sutures, taken from either side in a manner to reinforce and strengthen the covering struc-

¹ Zur Chirurgie des Rückenmarksbrüche: Prag. medicinische Wochenschrift, 1889.

tures, and the wound sealed. The recovery was rapid, without incident, and resulted in a firm solid cicatrix.

Dr. J. C. Cockburn,¹ of Minneapolis, reported a case treated by excision with recovery. Tumor located over sacrum, resembling in size and shape the larger end of a hen's egg. Operation November 14, 1889, performed aseptically. An elliptical incision was made around tumor, keeping well back into the healthy skin. The dissection was slowly and carefully made down to the spinal column, which was readily reached, except at inferior portion, where a dense, fibrous band or mass connected the tumor and the sacrum. The pedicle was separated from this fibrous band, and the latter cut through. The knife was then raised and the tumor compressed in order to return as much of the spinal fluid as possible within the membranes of the spinal cord, and a stout catgut ligature tied round the pedicle. Sudden failure of respiration followed on tightening the ligature. A trocar was thrust into the tumor, and three fluid ounces of cerebro-spinal fluid withdrawn; the sac was cut open, and the cauda equina was found included in the ligature, and the extremity adherent to the dorsal lining of the sac. With the hips elevated, the ligature around the pedicle was quickly cut. The caudal extremities and that portion of the dura to which they were attached were hurriedly dissected from the sac, and an unsuccessful attempt made to return this mass within the spinal canal. The sac was excised close to the ligature, and the stump returned within the spinal canal. The wound was then closed by deep and superficial catgut sutures, and a braided catgut drainage left in the lower portion of the wound. One month after operation wound was completely healed, cicatrix smooth. April 11, 1890, five months after operation, child healthy, vigorous, and no nervous symptoms.

Mr. J. Stewart² reported a case of excision of the sac of spina bifida operated on by Dr. Leonn. Child otherwise healthy. Tumor, size of a hen's egg, in the lower lumbar region, the membranes were semitransparent, the tip of the forefinger easily plugging the opening in the bone. Two flaps of healthy skin were dissected from the sac and a ligature of chromicized catgut placed round the pedicle. After opening the sac, and finding no nerves present, he tied his ligature, cut away the sac, and stitched up the flaps. Union by first intention.

¹ American Journal of the Medical Sciences, August, 1890, p. 165.

² British Medical Journal, February 21, 1891.

Dr. R. H. Seelye,¹ of Springfield, Mass., reported the case of a boy, three years old, upon whom he operated in May. Tumor, over second lumbar vertebra, size of an English walnut at birth, but had increased until it measured 22 centimetres in circumference. It was dissected to the base, which measured only 175 millimetres in circumference, ligated, tumor excised, and the superjacent parts sutured. Union was primary, and four months after operation there was no return, no tenderness, and the cure seemed complete. Fluid that escaped clear, specific gravity 1006; no nerve elements were found in the sac.

From the above record, Dr. Trowbridge was, undoubtedly, the first to plan deliberately to dissect the sac, open the canal, and treat intelligently the varying conditions, and then close the wound. His first two cases, treated by slow compression, had taught him that by these measures the sac had not taken on adhesive inflammation, although the integuments had sloughed. In closing his article, he commented upon the advisability of operative procedure, and states that about thirty cases of spina bifida had come under his personal observation and study. It does not appear that Dr. Purdy, of New York, who operated nearly twenty years later, knew of the experience of Dr. Trowbridge, but it is very probable. He was the second to publish his experience in dissecting the parts, excising the sac, and closing the wound. Mr. Page's operation, published in 1847, was undertaken only as a secondary consideration, after repeated attempts to cure by elastic compression.

Dr. Sayre operated by transfixing the small pedicle, and ligaturing tightly without dissection.

Thus it appears that, in this early formative stage of American surgery, operative measures undertaken for the cure of spina bifida, born from a suggestion of Sir Charles Bell, in a preceding generation, were crowned with success; and were as effective as it was possible to make them, until applied under the later knowledge, which renders aseptic surgery the crowning glory of the present century.

¹ Boston Medical and Surgical Journal, November 17, 1894.